Brain wave synchronization and entrainment to periodic acoustic stimuli

As known, different brainwave frequencies show synchronies related to different perceptual, motor or cognitive states. Brainwaves have also been shown to synchronize with external stimuli with repetition rates of ca. 10–40 Hz. However, not much is known about responses to periodic auditory stimuli with periodicities found in human rhythmic behavior (i.e. 0.5–5 Hz). In an EEG study we compared responses to periodic stimulations (drum sounds and clicks with repetition rates of 1–8 Hz), silence, and random noise. Here we report inter-trial coherence measures taken at the Cz-electrode that show a significant increase in brainwave synchronization following periodic stimulation. Specifically, we found (1) a tonic synchronization response in the delta range with a maximum response at 2 Hz, (2) a phasic response covering the theta range, and (3) an augmented phase synchronization throughout the beta/gamma range (13–44 Hz) produced through increased activity in the lower gamma range and modulated by the stimulus periodicity. Periodic auditory stimulation produces a mixture of evoked and induced, rate-specific and rate-independent increases in stimulus related brainwave synchronization that are likely to affect various cognitive functions. The synchronization responses in the delta range may form part of the neurophysiological processes underlying time coupling between rhythmic sensory input and motor output; the tonic 2 Hz maximum corresponds to the optimal tempo identified in listening, tapping synchronization, and event-interval discrimination experiments. In addition, synchronization effects in the beta and gamma range may contribute to the reported influences of rhythmic entrainment on cognitive functions involved in learning and memory tasks.